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CRYPTOCORYNETES HAPTODISCUS, NEW GENUS, NEW SPECIES, AND *SPELEONECTES BENJAMINI*, NEW SPECIES, OF REMIPEDE CRUSTACEANS FROM ANCHIALINE CAVES IN THE BAHAMAS, WITH REMARKS ON DISTRIBUTION AND ECOLOGY

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Abstract.—Two additional members of the crustacean class Remipedia, *Speleonectes benjamini* n. sp., and *Cryptocorynetes haptodiscus* n. gen., n. sp., are described from anchialine caves on the Little Bahama Bank in the northern part of the Bahamas. The Bahamian anchialine caves in which remipedes are found represent a low oxygen environment.

Since the discovery in Lucayan Cavern, Grand Bahama Island, of the first representative of the crustacean class Remipedia, *Speleonectes lucayensis* Yager (1981), additional members of the class have been found in the low oxygen waters of anchialine caves throughout the Bahamian archipelago. Outside of the Bahamas, undescribed remipedes were collected in 1986 from an anchialine cenote on the Yucatan Peninsula, and in addition, *Speleonectes ondinae* (Garcia-Valdecasas), the second species of the genus *Speleonectes,* was discovered in a submerged lava tube in the Canary Islands (see Garcia-Valdecasas 1984, Iliffe et al. 1984, Schram et al. 1986). Remipedes appear to be common components of low oxygen anchialine cave communities in the north Atlantic Ocean, especially in the West Indies region (Table 1).

In the summer of 1984, a joint British-USA-Bahamian cave diving expedition surveyed many anchialine caves on and near Sweeting's Cay at the east end of Grand Bahama Island. Two of the caves explored, Sagittarius and Asgard, were inhabited by *Speleonectes benjamini,* described below, the third species of the genus *Speleonectes* to be described. Also in 1984 the biological survey of several previously unexplored caves on Grand Bahama and Abaco Islands resulted in the collection of an unusual new genus and species of remipede, *Cryptocorynetes haptodiscus,* described below.

Speleonectes benjamini, new species
Figs. 1–6

Material examined.—BAHAMAS: Grand Bahama Island, Sweeting's Cay, Asgard Cave, holotype, adult, 16.8 mm, USNM 228199, 27 Jul 1984, R. Palmer, S. Cunliffe.—Sagittarius Cave, 1 adult, 5 Jul 1984, R. Palmer; 1 adult, 25 Jul 1984, D. Williams.—Abaco Island, Dan's Cave, 2 adults, 26 Jul 1985, D. Williams, J. Yager. Nontype material retained in the collection of the author.

Diagnosis.—Antenna 1 very long, extending from one-half to two-thirds length of body. First maxilla with long, slender distal fang; segment 1 with narrow endite bearing 1 moderately long apical spine and at least 10 accessory spines. Trunk sternites developed as cuticular plates with posterolateral projections. Sternal bars of trunk segments 1–13 with concave posterior margins, 14th triangular, remaining bars concave to triangular until anal segment. Trunk appendages with many small, serrate, spine-like comb setae along distal margins of predistal segments.

Table 1.—List of known remipedes from anchialine caves of the West Indies region.

Grand Bahama Island: *Speleonectes lucayensis* *Speleonectes benjamini* *Cryptocorynetes haptodiscus* Undescribed "juvenile-like"	Cat Island: *Speleonectes* cf. *lucayensis* *Godzillius* cf. *robustus*
Abaco Island: *Speleonectes* cf. *lucayensis* *Speleonectes benjamini* *Cryptocorynetes haptodiscus* *Godzillius* cf. *robustus* Undescribed godzilliid Undescribed "juvenile-like" species	Providenciales Island: *Lasionectes entrichoma* North Caicos Island: *Lasionectes entrichoma* Undescribed species with discoid organs *Godzillius robustus* Yucatan Peninsula: Undescribed speleonectid
Andros Island: *Speleonectes* cf. *lucayensis*	

Description.—Body elongate, slender, with tiny setae dispersed over surface, without pigment or eyes; maximum length of specimens examined 16.8 mm. Cephalic shield small, tapered slightly at anterior end. Trunk segment numbers varying with age, maximum number in material examined 27. First trunk segment reduced and covered by cephalic shield; pleura from second segment posteriad projecting laterally. Sternites (Fig. 3C) developed as cuticular plates with triangular posterolateral projections. Transverse cuticular sternal bars posterior to each plate, with concave posterior margins on trunk segments 1–13 (Fig. 3C), triangular on segment 14, concave on several segments posterior to 14th segment, then triangular in shape until anal segment.

Frontal filaments long, slender, cylindrical, with short, tapered medial process. Antenna 1 (Fig. 1A) biramous, very long, slender, extending well beyond cephalon, about two-thirds length of body. Peduncle 2-segmented; proximal segment enlarged, bearing several rows of densely packed, fine esthetascs (Fig. 5A, B) draping over second antenna toward mouth; distal segment bifurcate. Dorsal ramus long, with at least 15 slender, elongate segments. Ventral ramus short, less than ½ length of dorsal ramus, with 10 to 14 segments; segments near base of ventral ramus indistinctly divided by partial sutures. Segments of both rami with short, simple setae along ventral margins, clusters of forked esthetasc-like setae (Fig. 3B) on distoventral margins, and at least 4 terminal setae on apical segments. Antenna 2 (Fig. 1B) biramous, smaller than antenna 1, not extending beyond cephalon. Protopod 2-segmented, with moderately long setae on medial margins. Exopod a single, large, oval article, extending laterally from distal segment of protopod, bearing about 54 long, finely plumose setae along entire margin. Endopod 3-segmented, curving laterally; first segment with moderately long setae on anterior margin; second segment with row of moderate to long anterior setae becoming a double row distally, and several short setae on posterior margin; third segment with row of about 30 setae, becoming a double row along anterior and distal margins; all setae plumose.

Labrum a prominent, fleshy lobe, with distinct transverse groove; anterior half triangular and slightly raised at apex; posterior half with dense array of fine setae along margin of fossa. Mandibles well developed, asymmetrical. Right mandible with 3-cusped incisor process and 3-cusped lacinia mobilis. Left mandible (Fig. 1C) with 4-cusped incisor process and crescent-

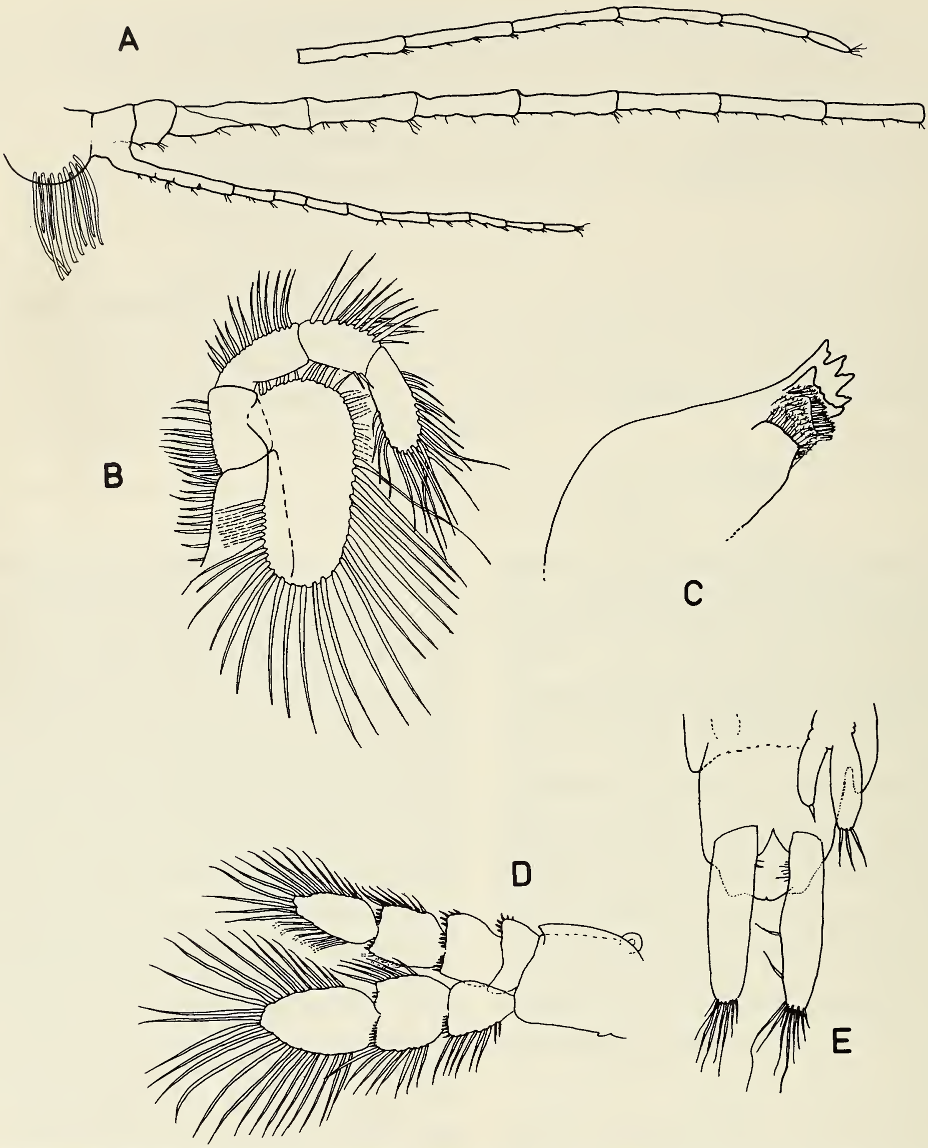

Fig. 1. *Speleonectes benjamini,* new species. A, Antenna 1; B, Antenna 2; C, Left mandible; D, 14th trunk appendage with gonopore; E, Anal segment with caudal rami and one terminal trunk appendage.

shaped lacinia mobilis. Molar process of both broad, bearing long, thick, multitipped setae. Paragnath (Fig. 4A) a round, flattened lobe with dense covering of fine, hair-like setae along margin.

First maxilla (Fig. 2A) 7-segmented, uniramous, prehensile, robust. Segment 1 (Figs. 2B, 4A) with long, narrow endite terminating in 1 long spine and up to 10 shorter, stout subterminal spines arranged in opposing pairs. Segment 2 (Fig. 4A) with endite as broad, plate-like flap lying over paragnath and bearing at least 8 short spines on terminal margin, flanked by parallel row of many short, simple setae; a row of long setae on anterolateral margin, and a few

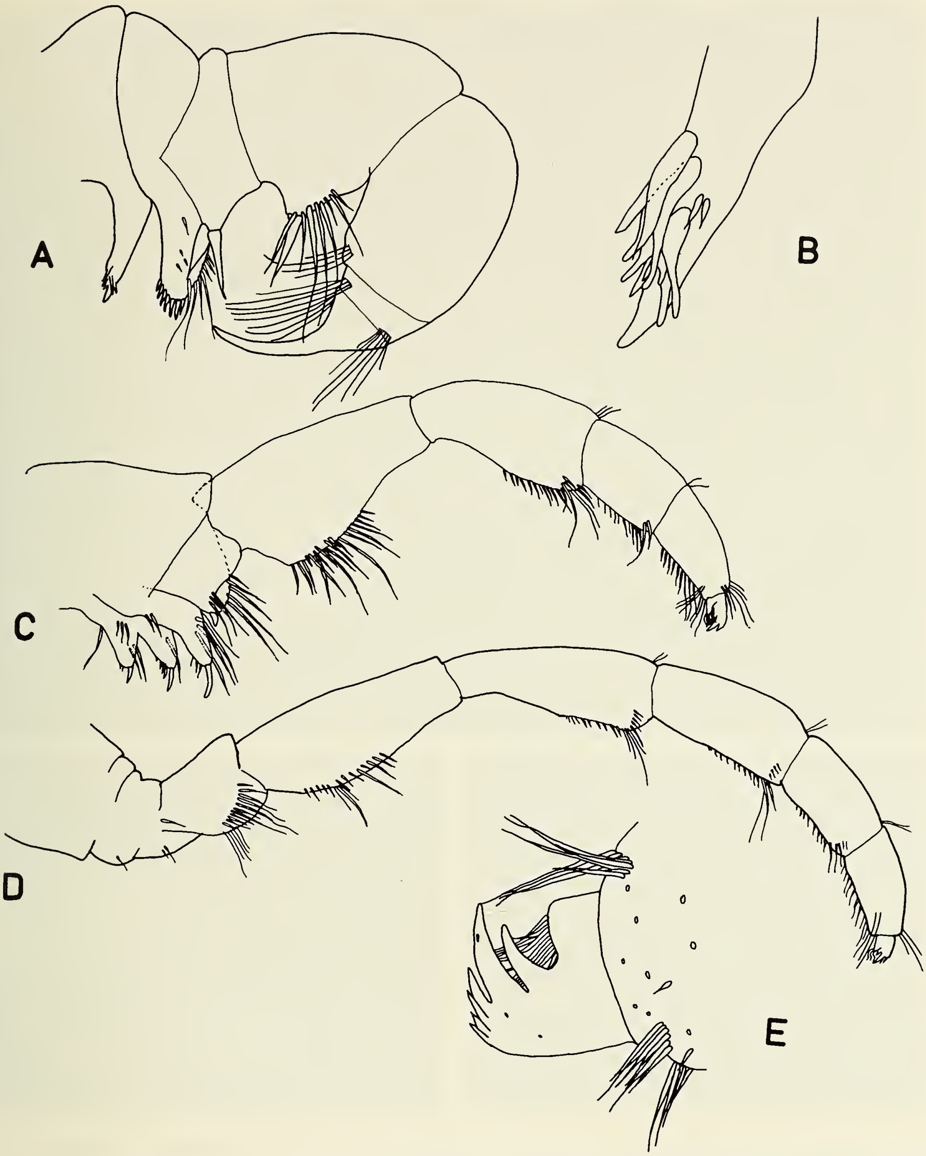

Fig. 2. *Speleonectes benjamini,* new species. A, Maxilla 1; B, Maxilla 1, endite of first segment; C, Maxilla 2; D, Maxilliped; E, Claw complex of maxilliped.

short to long setae near base of endite. Segment 3 with conical medial endite (see Fig. 4A) terminating in 2 robust, conical setae with fine serrations on distal halves, flanked posteriorly by cluster of several short to moderate setae. Segment 4 longer than segment 3, medial margin rounded, with 1 robust, serrate proximal seta and 2 rows of setae; setae of anterior row long, serrate, setae of posterior row less robust than those of anterior row, short to long, simple. Principle flexure of appendage between segments 4 and 5. Segment 5 about as long and wide as segment 4, with cluster of setae on anterior and posterior distomedial margins. Segment 6 very short, with cluster of long

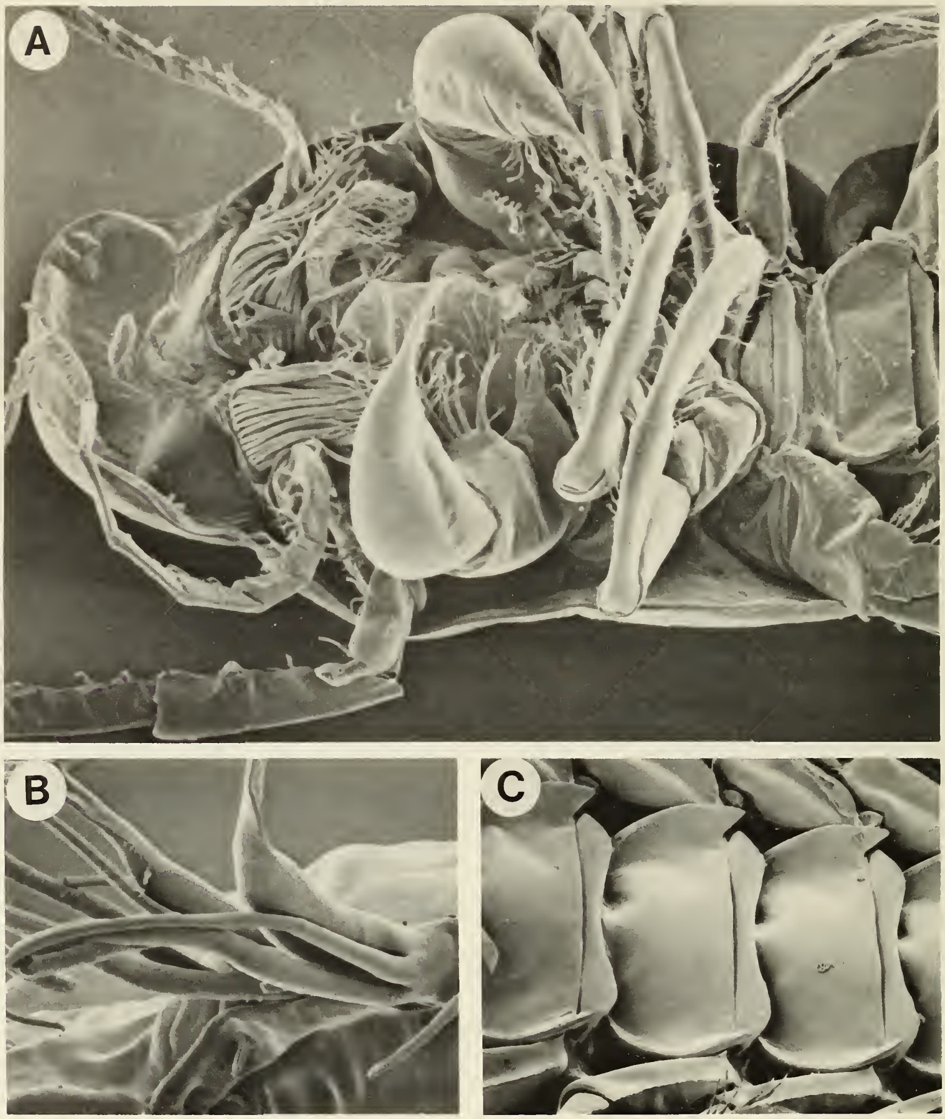

Fig. 3. *Speleonectes benjamini,* new species. A, Head appendages (29×); B, Antenna 1, branching, esthetasc-like setae (1330×); C, Sternal plates with cuticular bars (56×).

simple setae on anterior and posterior distomedial margins and cluster of moderate to long setae on anterior and posterior distolateral margins. Segment 7 a single long, slender fang (Fig. 3A) about 3 times as long as segment 6, with terminal pore and tuft of long, fine, simple setae at base medially.

Second maxilla (Fig. 2C) 7-segmented, uniramous, prehensile, longer than maxilla 1. Segment 1 with 2 small, weakly developed lobes posteriorly, bearing a few short setae each; 3 anteriorly-directed digitiform endites, progressively larger distally; each endite with single, curved terminal spine-like seta, several small subterminal spine-like setae, and several moderately long setae anterolaterally. Segment 2 shorter than segment 1, with small, rounded endite bearing

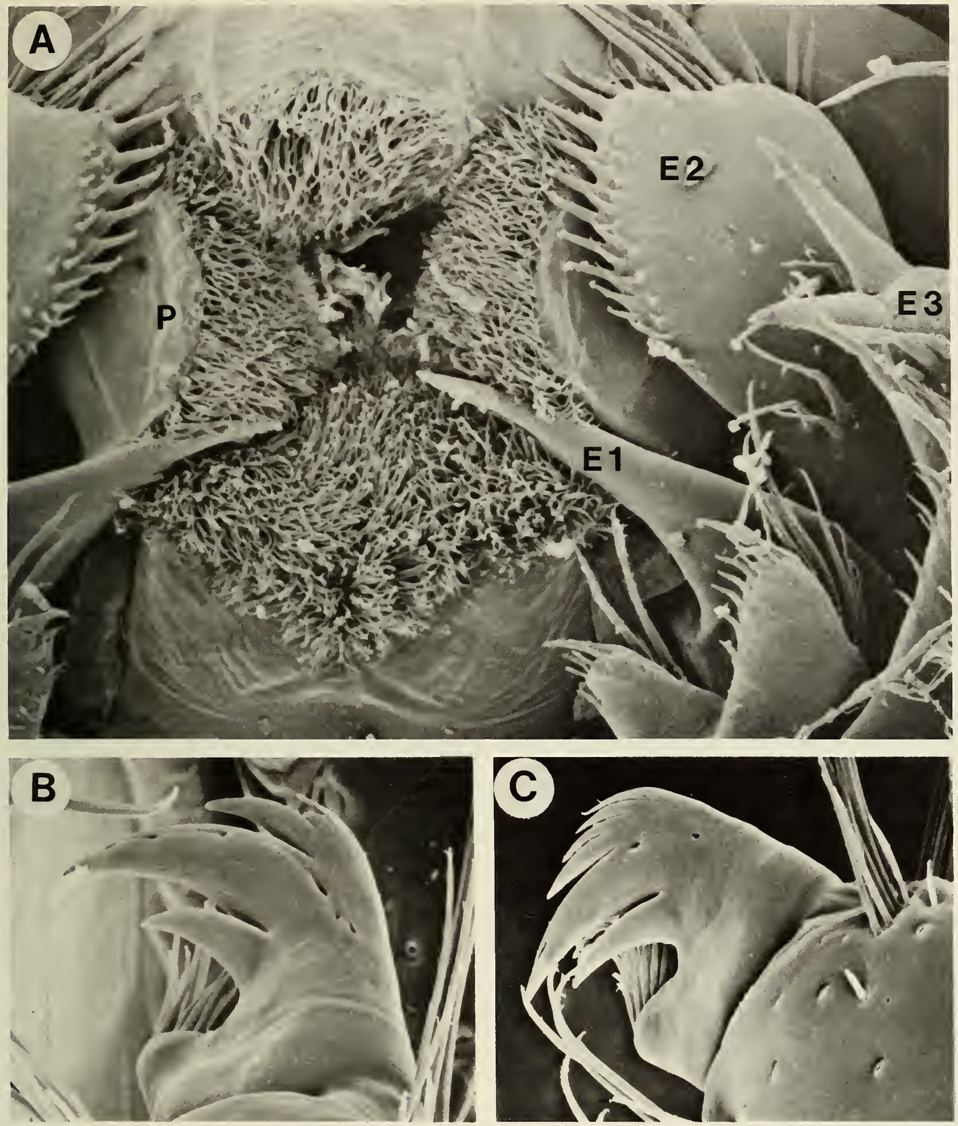

Fig. 4. *Speleonectes benjamini,* new species. A, Mouth area (117×), P—paragnath, E1—maxilla 1, endite of first segment, E2—maxilla 1, endite of second segment, E3—maxilla 1, endite of third segment; B, Maxilla 2, claw complex of terminal segment (650×); C, Maxilliped, claw complex of terminal segment (527×).

1 short, stout, apical spine-like seta and 2 rows of setae, setae of anterior row long, serrate, setae of posterior row short to moderately long. Segment 3 long, with proximomedial rounded bulge bearing 2 rows of setae; anterior row with many moderate to long serrate setae, posterior with fewer short to moderate setae. Principle flexure of appendage between segments 3 and 4. Segment 4 about as long as segment 3, with row of many moderate to long setae along distomedial margin, cluster of moderately long setae on anterior and posterior distomedial margins, and several small setae on distolateral margin. Segment 5 shorter than segment 4, with row of many moderate to long

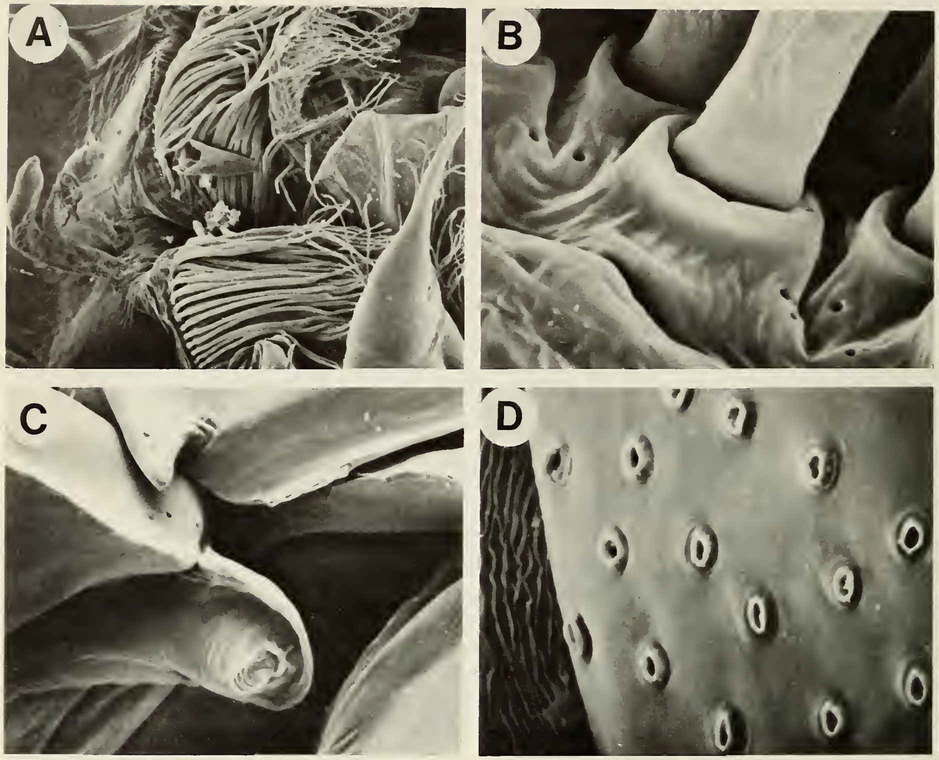

Fig. 5. *Speleonectes benjamini,* new species. A, Antenna 1, esthetascs (85×); B, Antenna 1, closeup of base of esthetascs (2200×); C, Gonopore (136×); D, Porous plate adjacent to gonopore (1710×).

setae along entire medial margin; cluster of several small to moderate setae on anterior and posterior distomedial margins, several small setae on distolateral margin. Segment 6 about as long as segment 5, with row of moderate to long simple setae along medial margin; cluster of moderate to long setae on anterior and posterior distomedial margins, and several moderate to long setae on anterior and posterior distolateral margins. Segment 7 (Fig. 4B) with claw complex consisting of 1 long, stout, anterior claw, flanked subterminally by smaller, stout claw, and posterior horseshoe-shaped arrangement of smaller spines; pores on surface of claw complex. Thumb-like pad bearing many long, simple, esthetasc-like setae opposing claw complex.

Maxilliped (Fig. 2D) similar in form but longer than maxilla 2, having 1 more segment beyond point of flexure; 8-segmented, uniramous, prehensile. Segment 1 indistinctly subdivided with several weakly developed lobes bearing a few short medial setae. Segment 2 with medial lobe bearing anterior row of long, serrate setae and posterior row of short to moderate simple setae. Segment 3 moderately rounded, with 2 rows of setae, anterior setae longer and more numerous than those of posterior row. Principle flexure between segments 3 and 4. Segments 4, 5, and 6 with medial row of short to moderate setae, clusters of several long anterior and posterior distomedial setae, and several setae on distolateral margins. Segment 8 (Figs. 2E, 4C) with claw complex and opposable pad similar to maxilla 2.

Trunk appendages (Fig. 1D) biramous, paddle-like swimming appendages becoming smaller and less setose near anal seg-

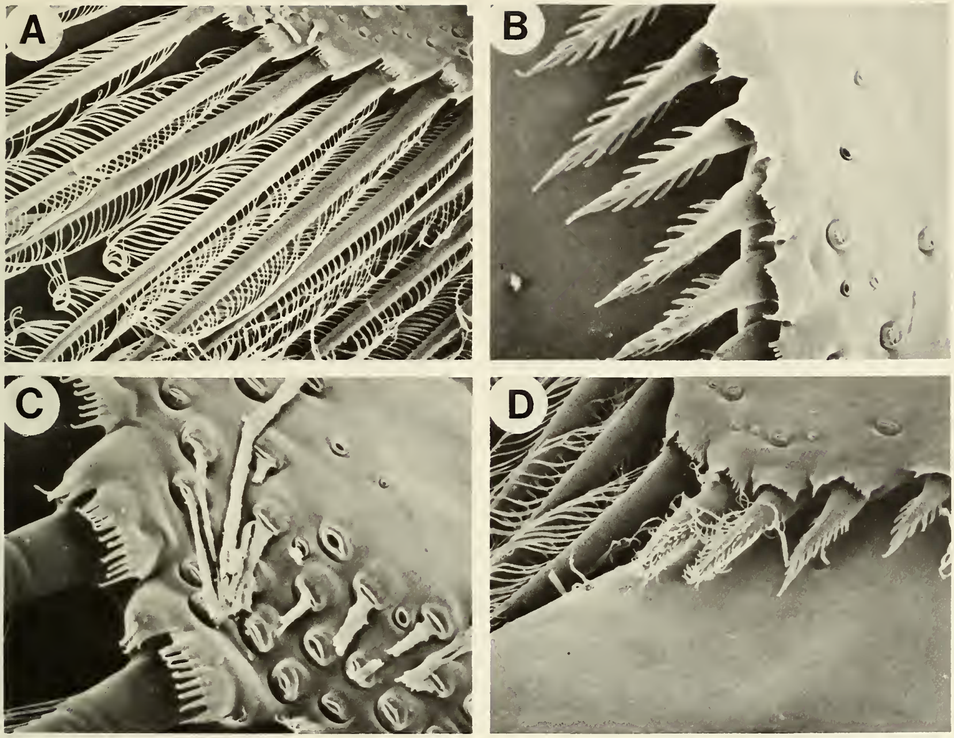

Fig. 6. *Speleonectes benjamini,* new species. A, Plumose setae of trunk appendage (308×); B, Short, serrate comb setae of trunk appendage (893×); C, Closeup of trunk segment showing porous nature and cuticular fringe of setal sockets (932×); D, Trunk appendage showing three types of setae (591×).

ment; three distinct setal types: short comb setae bearing well-developed serrations (Fig. 6B); short, with fine serrations dispersed on surface (Fig. 6D); long, plumose (Fig. 6A). Protopod large, subrectangular; cuticle on ventral side of medial margin forming lateral flap-like extension or ridge. Endopod 4-segmented; proximal segment short, rectangular, with several distomedial, short setae; segment 2 subrectangular, with many comb setae along distal margin of segment and several circumserrate setae medially; segment 3 subrectangular with moderate to long plumose setae (Fig. 6A) on lateral and medial margins and many comb setae along distal margin; segment 4 oval with long, plumose setae along entire margin. Exopod 3-segmented; segment 1 subrectangular with short to moderate, lateral, plumose setae and many comb setae along distal margin; segment 2 with moderately long plumose setae on lateral and medial margins and many comb setae along distolateral margin and a few on distomedial margin; segment 3 oblong, with long, plumose setae along entire margin. All three setal types arising from well-developed sockets, each with a fine cuticular fringe (see Fig. 6C). Distal part of segments with many small pores, some with visible secretion (Fig. 6C). Gonopore (Fig. 5C) on 14th trunk appendage at base of protopod, protected by small triangular cuticular flap. Genital plate (Fig. 5D) proximal to gonopore, bearing many pores; not found in all specimens. Anal segment (Fig. 1E) about as long as wide; caudal rami cylindrical, slightly longer than anal segment, with about 10 short to moderate terminal setae, several medial setae, and about 6 short setae basomedially, near anus.

Etymology.—This species is named in honor of the pioneer of Bahamian cave diving, Dr. George Benjamin, in recognition of his enthusiastic exploration of Bahamian ocean blueholes as well as his innovative design of safe cave diving equipment.

Habitat.—Asgard (type locality) and Sagittarius Caves are anchialine caves which formed beneath the small island of Sweeting's Cay off the eastern end of Grand Bahama Island (see Cunliffe 1985). The remipedes were collected beneath the density interface in low oxygen, polyhaline (18–30 ppt) water. Other animals collected from the water column include two species of Remipedia (*Speleonectes* cf. *lucayensis* and an undetermined "juvenile-like" species which also occurs in Dan's Cave, Abaco), the amphipod *Bahadzia williamsi,* the isopod *Bahalana geracei,* undescribed species of thermosbaenaceans, two species of ostracodes (*Deeveya* sp. and another new species), the mysid *Stygiomysis holthuisi,* and the blind cave fish *Lucifuga spelaeotes.*

Relationships.—*Speleonectes benjamini* is morphologically similar to the other two speleonectids, *S. lucayensis* and *S. ondinae.* The most obvious distinguishing characters of *S. benjamini* are the very long first antenna and the long, slender fang of the first maxilla. The genus *Speleonectes* is characterized by the morphology of the three prehensile feeding appendages. The first maxilla is the most robust due to the wide third and fourth segments. In contrast, the second maxilla and maxilliped are narrower and more elongate. The third segment of those appendages is rounded, with a rounded medial bulge bearing parallel rows of moderate to long setae. The second segment of the first maxilla in all three species bears two robust, conical setae, the distal part of which is finely serrate. The first maxilla has several characters which differ at the species level. For example, the third segment of this appendage bears a single robust, multiserrate, proximal seta on *S. benjamini,* but five in *S. ondinae. S. ondinae* and *S. lucayensis* bear a distal fang approximately the same length while the fang of *S. benjamini* is more than twice as long. Another difference in the first maxilla is the first or proximal endite on segment 1: this endite on *S. benjamini* bears one long spine and at least nine shorter, stout, accessory spines, whereas in the other two species it bears one long spine and only six stout accessory spines. The second maxilla and maxilliped of the three known speleonectids are very similar, differing slightly in the shape of the distal claw complex; the maxilliped of *S. benjamini* is more slender than that of *S. lucayensis.*

Cryptocorynetes, new genus

Diagnosis.—Maxilla 2 and maxilliped with inflated distal segments bearing many stalked discoid organs. Sternites of trunk segments developed as plates, with small triangular posterolateral projections. Transverse sternal bar along posterior edge of sternite narrow rectangle on segments 1–13, a triangular flap from segment 14 to anal segment. First segment of maxilla 1 bearing elongate proximal endite with 1 long spine and 9 smaller spines.

Type species.—*Cryptocorynetes haptodiscus* n. sp. by monotypy.

Etymology.—The name is derived from the Greek *cryptos* meaning "hidden," and *corynetes* meaning "club-bearer." It refers to the cryptic habitat and to the inflated club-like segments on the second maxilla and maxilliped. The gender is masculine.

Cryptocorynetes haptodiscus, new species
Figs. 7–10

Material examined.—BAHAMAS: Abaco Island, Dan's Cave, holotype, 9.8 mm, USNM 228198, 7 Jun 1984, D. Williams.—Abaco Island, Dan's Cave, 1 adult, 24 Dec 1984, and 4 subadult specimens, 26 Jul 1985, D. Williams and J. Yager.—Grand Bahama Island, Mermaid's Lair, Old Freetown Cave System, 1 adult, 30 Apr 1984, D. Williams and J. Yager. Non-type material retained in collection of the author.

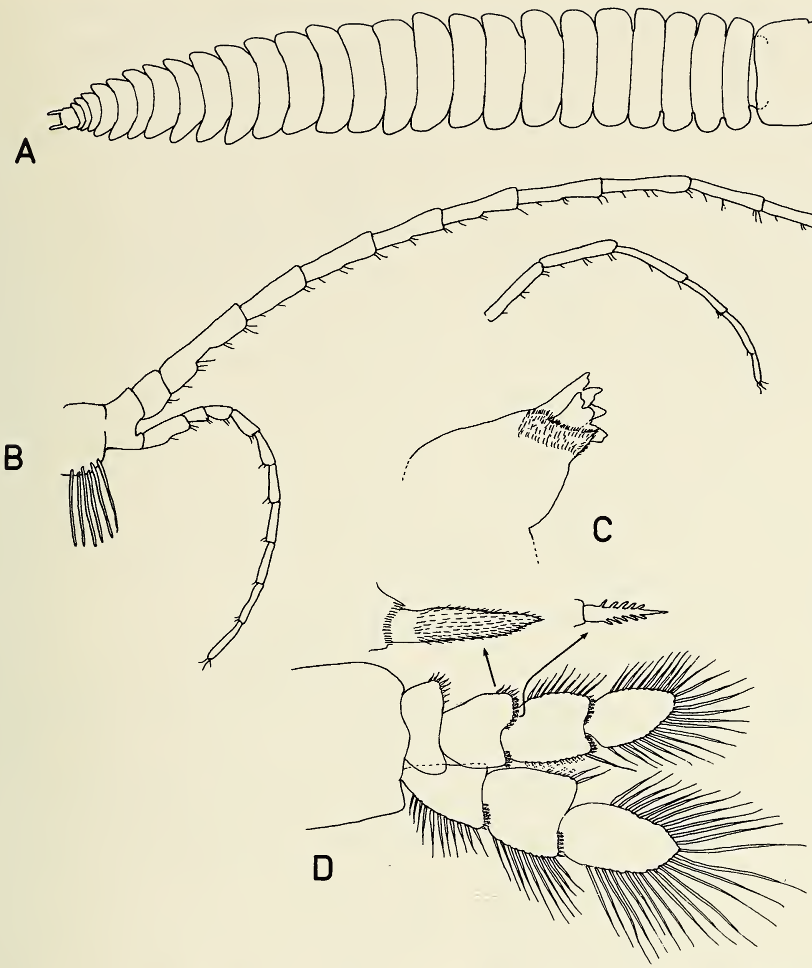

Fig. 7. *Cryptocorynetes haptodiscus,* new genus, new species. A, Dorsal view, appendages omitted; B, Antenna 1; C, Right mandible; D, Trunk appendage showing small circumserrate seta and comb seta.

Description.—Body elongate (Fig. 7A), slender, without pigment or eyes, maximum length of specimens examined 16.3 mm. Cephalic shield small, tapered slightly at anterior end. Numbers of trunk segments varying with age; maximum number in specimens examined, 32. Trunk (Fig. 7A) with rounded tergites and lateral pleura. First trunk segment reduced in length and width, partly covered by posterior edge of cephalic shield. Sternites developed as plates with small triangular projection at posterolateral corners, similar to those of *S. benjamini.* Cuticular bar on posterior edge of sternal plate, extending between bases of trunk appendages; bars on segments 1–13 narrow rectangular to slightly convex posteriorly, changing to triangular flap from segment 14 and beyond.

Frontal filaments small, broad-based, with slender, thumb-like ventromedial process. Antenna 1 (Fig. 7B) biramous, long, slender, extending beyond cephalon. Peduncle 2-segmented; proximal segment enlarged, bearing several rows of long, lash-like esthetascs extending posteriorly over antenna 2; distal peduncular segment bifurcate. Dorsal ramus with 16–18 segments; ventral ramus with 10–12 segments, less than one-third length of dorsal ramus. Segments of both rami with short, simple setae and several tufts of forked esthetascs along distomedial margins similar to those of *Speleonectes benjamini* (see Fig. 3B); 2–4 terminal setae on apical segments. Antenna 2 biramous, smaller than antenna 1, not extending beyond cephalon, similar to that of *S. benjamini* (see Fig. 1B). Protopod 2-segmented, with setae on medial margins. Exopod a large, single oval article, extending laterally from distal protopod segment and bearing at least 35 long, finely plumose setae along margin. Endopod 3-segmented, curving laterally; first and second segments with setae along margins, distolateral setae arranged in double rows; third segment with at least 20 setae, becoming a double row of 8–10 along distal margin. All setae plumose.

Labrum (Fig. 9A) a prominent lobe with triangular anterior apex, posterior half broad, with finely setose fossa along posterior margin. Mandibles slightly asymmetrical; right mandible (Fig. 7C) incisor process with 3 large, dentate cusps, lacinia mobilis 3-cusped; incisor process of left mandible with 4 dentate cusps, lacinia mobilis small, crescent-shaped. Molar processes broad, well developed, covered with long, dense, multitipped setae. Paragnath round, plate-like, densely covered with fine setae along margin; partly covered by broad endite of first segment of maxilla 1.

First maxilla (Fig. 8A) 7-segmented, uniramous, prehensile. Segment 1 (Fig. 8B) with long, narrow endite terminating in 1 long tooth-like spine and at least 6 shorter, stout spines. Segment 2 endite as broad, plate-like flap overlying paragnath and terminating in at least 6 short spines flanked by parallel row of smaller, fine setae; anterolateral margin of endite with row of moderate to long simple setae. Articulation between segments 2 and 3 oblique. Segment 3 short, with truncate endite bearing at least 3 robust setae with long, finely circumserrate setae (Fig. 8A) and several moderately long, simple setae on anterior and posterior margins. Segment 4 longer than segment 3, produced medially into rounded lobe, bearing at least 1 relatively large, proximal seta with relatively long, fine serrations on distal half, and rows of short to long setae, setae of anterior row large, circumserrate, similar to apical seta, setae of posterior row smaller. Segment 5 about as long as segment 4, narrower, with several fine, simple setae on anterior and posterior distomedial margins and several setae distolaterally. Segment 6 short, with cluster of moderately long, fine, simple setae on anterior and posterior distomedial margins and cluster of moderately long, simple setae on both anterior and posterior distolateral margins. Segment 7 a single fang, only slightly longer than segment 6, with terminal pore and tuft of long, fine, simple setae at medial base.

Second maxilla (Fig. 8C) 7-segmented, uniramous, prehensile, longer and slightly more robust than maxilla 1. Segment 1 with 3 obliquely anteriorly directed digitiform endites increasing in size distally. Each endite with single terminal, curved spine, several short subterminal setae, and several moderately long setae on anterolateral margin. Segment 2 short, rounded medially, bearing 1 short spine-like proximal seta and 2 parallel rows of moderately long setae, anterior row with several large serrate setae and several smaller ones; posterior row with several short to moderately long setae and several discoid organs. Segment 3 long, expanded medially, anterior margin with at least 4 long setae, posterior margin with cluster of discoid organs. Segment 4 shorter than segment 3; distomedial margin slightly inflated, bearing several simple setae and a cluster of discoid organs, 1–2 small simple setae on distolateral margin. Segment 5 about as long as segment 4, distomedial surface inflated, bearing many discoid organs and several small, simple setae; several small setae on distolateral margins. Segment 6 inflated; medial surface covered with discoid organs (Fig. 8C); cluster of long, simple setae

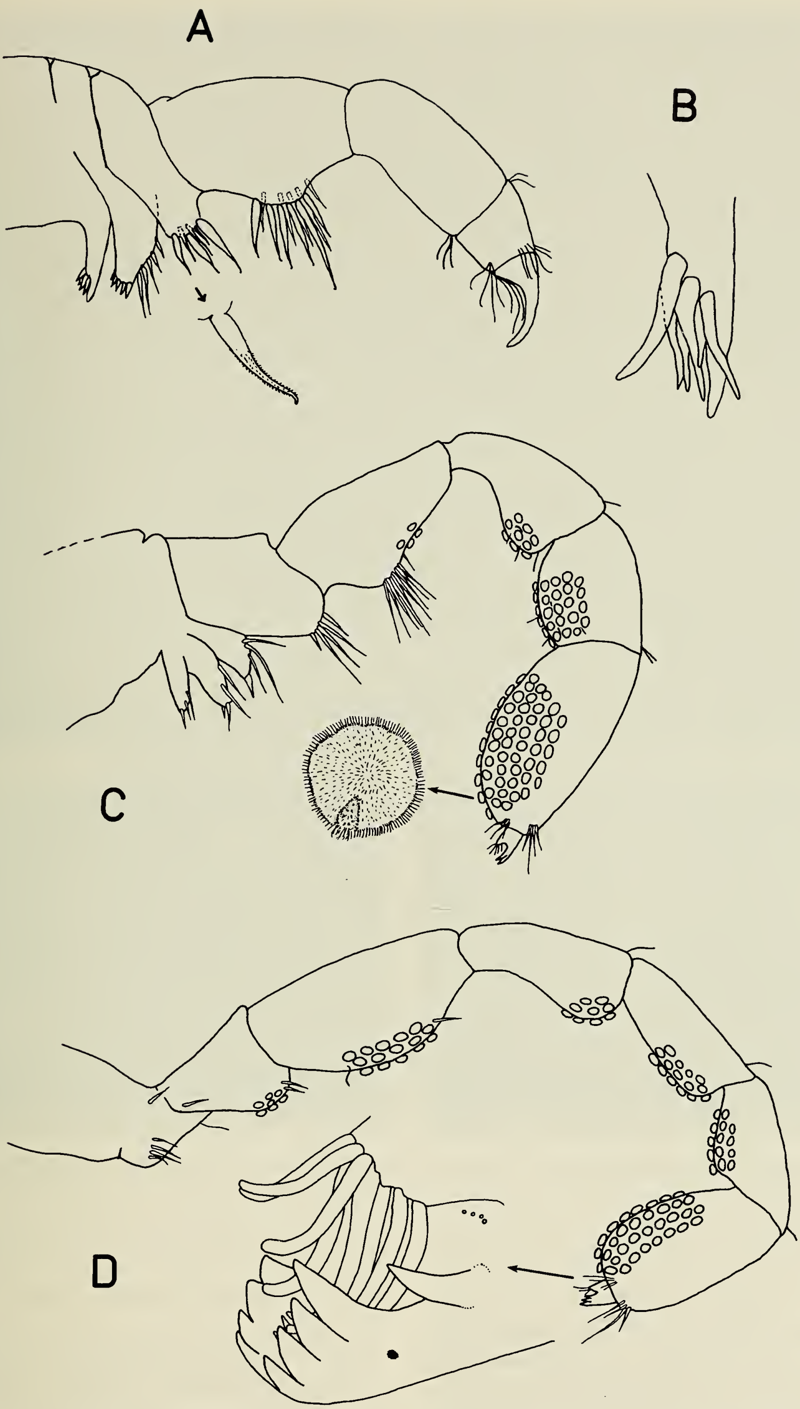

Fig. 8. *Cryptocorynetes haptodiscus,* new genus, new species. A, Maxilla 1, with serrate seta; B, Maxilla 1, endite of first segment; C, Maxilla 2, with enlarged discoid organ; D, Maxilliped, with enlarged claw complex.

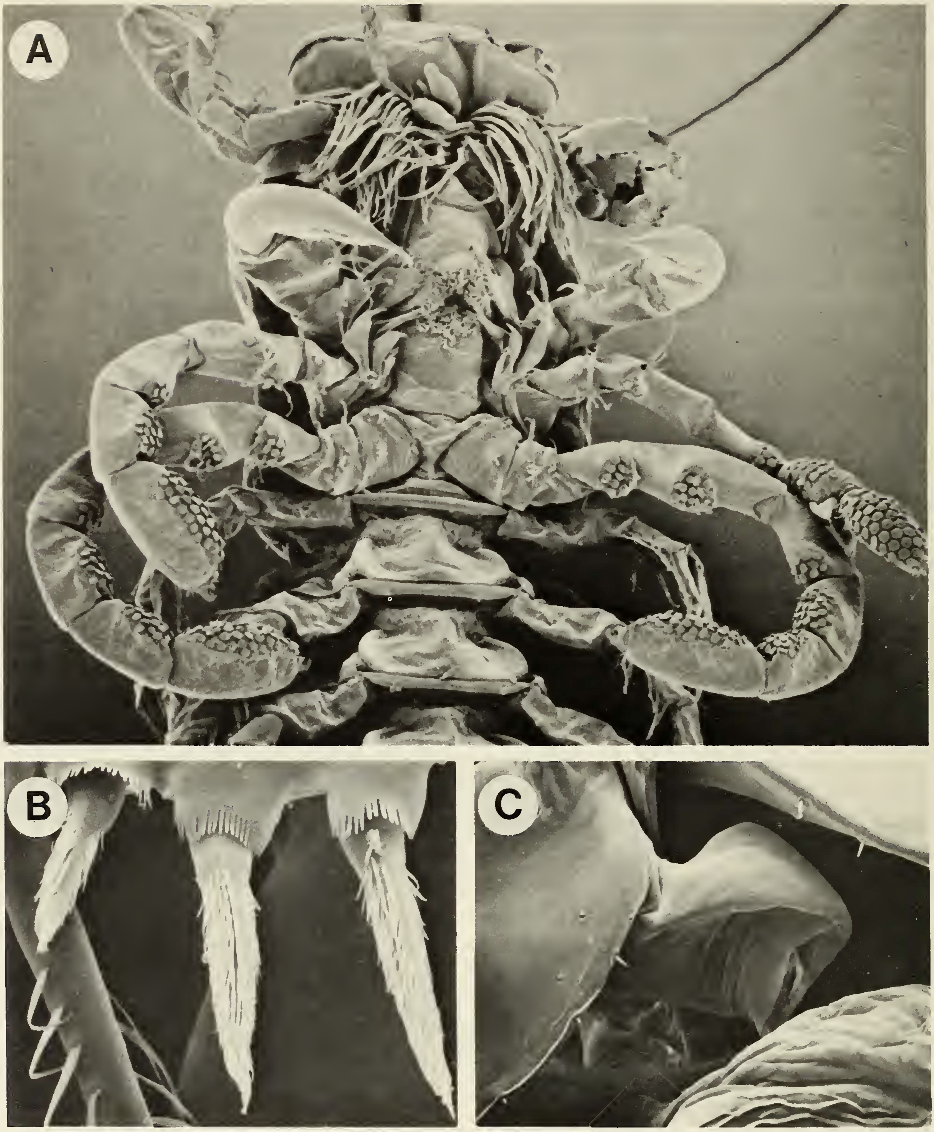

Fig. 9. *Cryptocorynetes haptodiscus,* new genus, new species. A, Head appendages, trunk segments 1–3, with sternal bars (54×); B, Small, finely circumserrate setae of trunk appendage (1230×); C, Gonopore (276×).

on anterior and posterior distomedial and distolateral margins. Segment 7 (Fig. 10B, C, D) terminating in claw complex consisting of 1 separate, anterior, subterminal claw and horseshoe-shaped arrangement of 1 robust anterior proximal claw and about 8 smaller spines fused at bases; one or more pores on surface of claw complex. Opposable, subterminal thumb-like pad bearing many long, simple, setae; row of small pores between pad and anterior single spine (see Fig. 10D).

Maxilliped (Fig. 8D) 8-segmented, uniramous, prehensile. Similar in appearance to maxilla 2, but longer, having 1 more segment beyond point of flexure. Proximal segment indistinctly subdivided, with very weak development of several medial lobes

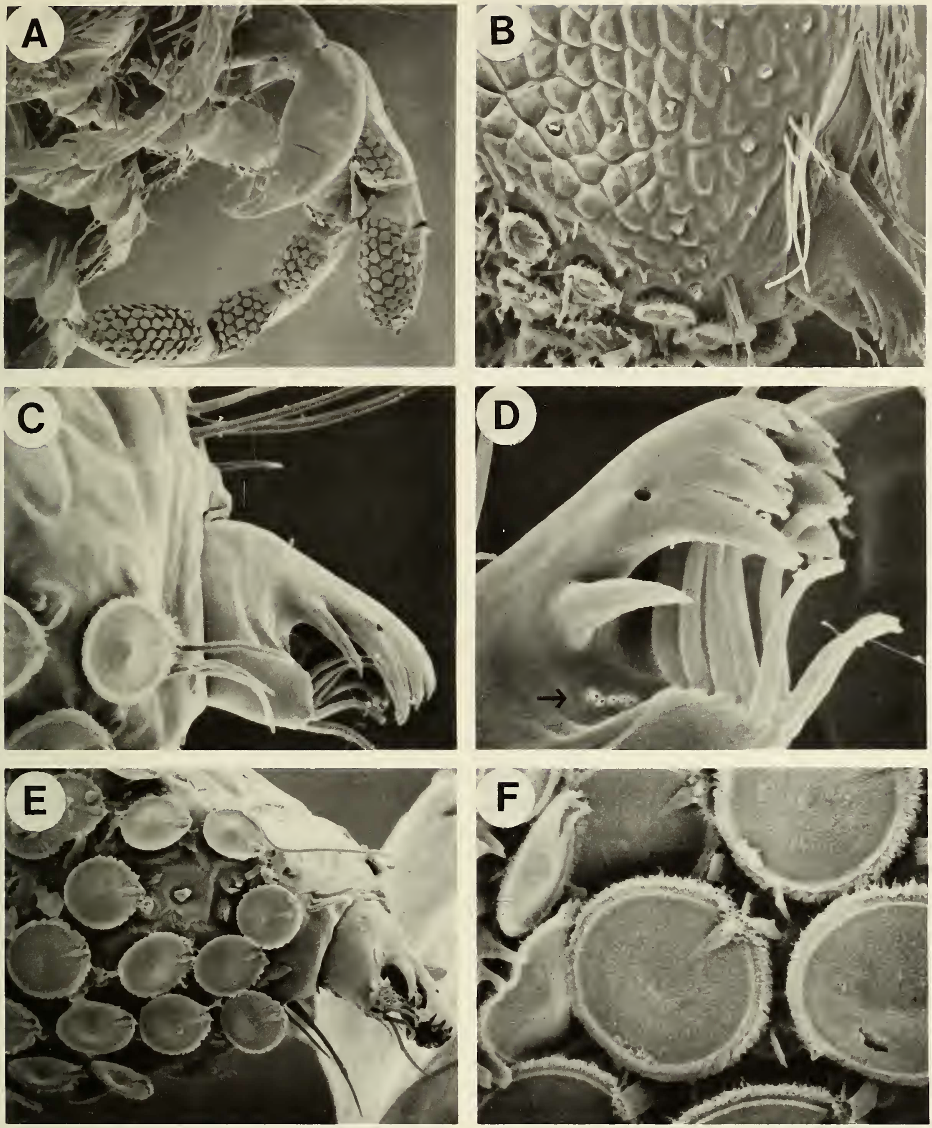

Fig. 10. *Cryptocorynetes haptodiscus,* new genus, new species. A, Raptorial head appendages (106×); B, Maxilla 2, terminal segments, closeup of raised polygonal microsculpture and discoid sensillae (261×); C, Maxilla 2, terminal segments (917×); D, Maxilla 2, terminal claw complex with setose pad, arrow indicates small pores (2450×); E, Maxilliped, terminal segments (713×); F, Discoid organs and ribbon-like structures (853×).

bearing a few medial setae. Segment 2 short, with rounded, medial lobe bearing several discoid organs and several short, simple setae distally. Segment 3 rounded medially, bearing many discoid organs and several simple setae. Segment 4 slightly shorter than segment 3, inflated distomedially, with discoid organs and 1 or more distolateral setae. Segments 5 and 6 about as long as segment 4, with medial inflation covered with discoid organs, distolateral margin with several small setae. Segment 7 long and greatly inflated, medial surface covered with many discoid organs and several simple setae;

cluster of short to long setae on anterior and posterior distomedial and distolateral margins. Segment 8 (Figs. 8D, 10E) with claw complex and opposable setose thumb-like pad similar to that of maxilla 2. Discoid organs (Fig. 10F) stalked; surface slightly raised in center, covered with fine setules and a single wedge-shaped ridge; outer margin of disc with fringe of very fine, densely packed setae; ribbon-like structures, or possibly secretions, coming from pores interspersed between discs.

Trunk appendages (Fig. 7D) biramous, obliquely laterally-directed, paddle-like swimming appendages decreasing in size and number of setae near anal segment; 3 types of setae as in *S. benjamini.* Protopod large, subrectangular, lacking setae. Endopod 4-segmented; proximal segment short, rectangular, with 1 or more small, circumserrate setae (Fig. 9B); segment 2 subrectangular, with small circumserrate setae along distolateral margin and several small comb setae (see Fig. 7D) along distal margin; segment 3 subrectangular with moderately long, plumose setae along sides and comb setae along distal margin; segment 4 oval. Exopod 3-segmented; first segment subrectangular, with moderate, lateral, plumose setae and comb setae on distal margin; segment 2 similar to segment 1, with additional setae along mediolateral margin; distal segment oval. Oval segments of both rami bearing very long, finely plumose setae. Endopod of trunk appendages 1–4 with moderate setae on distomedial margins decreasing in size posteriorly, until appendage 4 when they become short, circumserrate setae as described above. Gonopore (Fig. 9C) at base of protopod of 14th trunk appendage. Anal segment slightly broader than long, with cylindrical caudal rami about same length as segment; both rami with a few short medial setae and 8–10 moderately long, terminal setae.

Etymology.—The name is formed from a combination of the Greek words *haptos,* meaning "grasping," and *diskos,* meaning "disc" or "plate," in reference to the discoid organs.

Habitat.—The two caves in which *Cryptocorynetes* is found are typical of Bahamian anchialine caves (see Discussion). Dan's Cave (type locality) on Abaco Island is about 3 km from the sea. The entrance is through a small freshwater pool at the base of a cliff along a limestone ridge. The surface vegetation consists of pine forest with palmetto and poison wood. Other animals found in the aphotic zone with *Cryptocorynetes* include five apparently distinct species of Remipedia: *Speleonectes* sp. cf. *S. lucayensis, Speleonectes benjamini, Godzillius* sp. cf. *G. robustus* Schram, Yager, and Emerson (1986), an undescribed new genus of the family Godzilliidae, and the undescribed small, "juvenile-like" species found also in Asgard and Sagittarius Caves. Other inhabitants are the amphipods *Spelaeonicippe* sp. cf. *S. provo* and *Bahadzia williamsi,* the ostracod *Deeveya spiralis,* the cirolanid isopod *Bahalana geracei,* undescribed thermosbaenaceans, the blind cave fish *Lucifuga spelaeotes,* and the epigean spiny cheek sleeper fish *Eleotris pisonis.* The remipedes were collected in the water column below the density interface approximately 300 m from the surface entrance in polyhaline to euhaline water.

Mermaid's Lair, on Grand Bahama Island, is part of the Old Freetown Cave System, about 100 m inland from the ocean. This cave system has a freshwater lens to approximately 18-m depth, with deeper euhaline waters. The specimen of *Cryptocorynetes* from this cave was collected beneath the density interface.

Remarks.—The discoid organs of *Cryptocorynetes* appear to be unique within the Crustacea. Preliminary investigation with transmission electron microscopy indicates that they are innervated. In addition to the setose fringe, the surface of each disc is covered with tiny hair-like projections. The discs may serve as "nonskid" pads which facilitate the grasping and holding of a slippery or highly mobile prey item. Another remipede with similar discs on the second maxilla and maxilliped has been collected from a cave in the Turks and Caicos. Although it appears to be a new species, only one specimen was collected and additional material is necessary for taxonomic consideration. Several *Cryptocorynetes* specimens appear to have a raised polygonal microsculpture on the dorsal surface of the raptorial head appendages. This is especially evident in Fig. 10B.

Discussion

Several distinguishing characters are to be found in the structure of the raptorial first and second maxilla and maxilliped of remipedes. First is the relative size ratio of these appendages. In the three *Speleonectes* species, the first maxilla is robust with segments 3 and 4 about as broad as long. The second maxilla and maxilliped, though more elongate, are less robust and segments 3 and 4 are slender in comparison. In contrast, the first maxilla of *Lasionectes entrichoma* Yager and Schram (1986) is less robust than its second maxilla and maxilliped. The third segments of those two appendages are massive structures. The two long, robust, subchelate appendages of the 31-mm *Lasionectes* may enable the manipulation of its apparent prey item, a large (up to 15 mm) atyid shrimp found in great abundance in the type locality. In its type locality, the 24-mm *Speleonectes lucayensis* is found associated almost solely with abundant populations of thermosbaenaceans averaging about 5 mm in length. With enlarged distal segments and discoid organs, the second maxilla and maxilliped of *Cryptocorynetes* represent yet another kind of apparent feeding modification. It is likely that the enlarged surface area and presumed "nonskid" pads facilitate the capture and manipulation of a prey item quite different from that eaten by species of *Speleonectes*.

Another distinguishing feature of raptorial feeding appendages in remipede is the morphology of the first maxilla. For example, in *Speleonectes lucayensis,* the terminal fang is stout and short, only about twice as long as the segment proximal to it. The fang of *S. benjamini* is quite long and slender, about four times as long as the segment proximal to it. The third segment of the first maxilla of *Godzillius robustus* bears a long, stout fang and a long, club-like endite. Often several species of remipedes occur together in the same cave, and are collected within meters of each other, so it is unlikely that they are competing for space. The comparative morphology of the raptorial feeding appendages suggests that remipedians may avoid competition by prey selectivity.

The fourteenth trunk segment of each species bears the gonopore or genital opening. Some individuals have a small plate (see Fig. 5D) overhanging the gonopore. The plate is covered with pores which appear to be secretory in function. It is possible that this plate serves as a place for egg attachment. While sectioning the fourteenth trunk appendage of *Speleonectes benjamini,* sperm was discovered in the protopod. It was contained within a cell-lined pouch, possibly a seminal receptacle. While ovaries with immature oocytes and paired oviducts have been found, little is known about the reproductive biology of remipedes. I have not found mature eggs or testicular tissue, and it is not known whether they are dioecious or hermaphroditic.

The Bahamian archipelago consists of a long chain of limestone islands situated off of the east coast of Florida and extending 1000 km to the southeast. The archipelago is hypothesized to have originated as a continuous platform or megabank which began by shallow water carbonate deposition about 150 million years ago (Schlager and Ginsburg 1981). The Bahama Platform was subsequently divided up into smaller, disjunct banks by the development of deep water channels sometime during the Cretaceous (Schlager and Ginsburg 1981). The islands

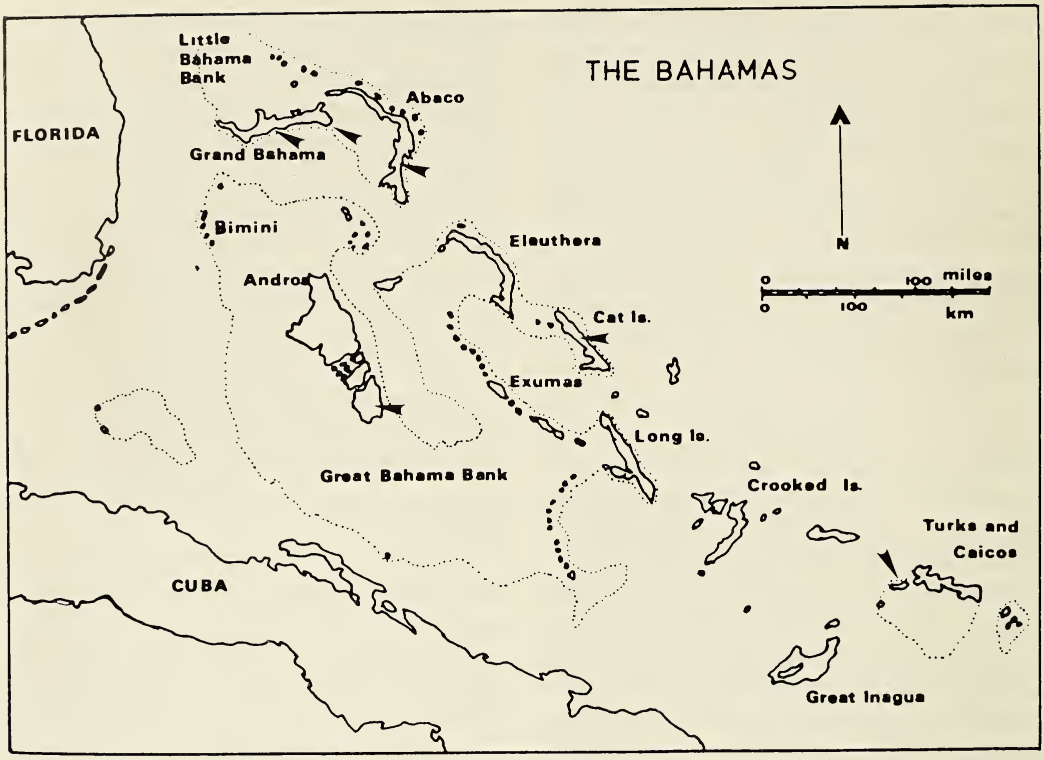

Fig. 11. Map of the Bahamian archipelago. Arrows indicate locations where remipedes have been collected.

that now make up the Bahamas and the Turks and Caicos are the tops of those banks (Fig. 11). The geographic distribution of remipedians known from the Bahamian archipelago is shown on Fig. 11.

Bahamian anchialine caves inhabited by remipedians are characterized by layers of increasingly haline water (Fig. 12). Water at the surface ranges from limnetic to polyhaline. There is a distinct density interface between waters of different salinities, and several haloclines may exist as depth increases. For example, on Grand Bahama Island, the location of the first density interface is at the bottom of the freshwater lens found on the island and has a maximum depth of about 20 m. The deeper aphotic passages have polyhaline to euhaline waters and can extend horizontally for many kilometers through the porous limestone. The distinguishing feature of the cave water beneath the first density interface is a significant drop in dissolved oxygen content. In contrast to a dissolved oxygen content of about 4 ppm or greater in the surface waters, some caves have a dissolved oxygen of less than 0.1 ppm in the water beneath the density interface. Remipedes have not been collected in cave water with a dissolved oxygen greater than 1 ppm. The processes by which the freshwater lens and density interfaces control the amount of oxygen in the water are poorly understood. However, the importance of this low oxygen for the ecology of remipedes cannot be ignored.

Anchialine environments in Bermuda have yielded a diverse cavernicolous marine fauna (Sket and Iliffe 1980). However, to date, remipedians have not been collected from Bermuda caves. The anchialine caves of Bermuda lack the overlying freshwater lens and density interfaces, and con-

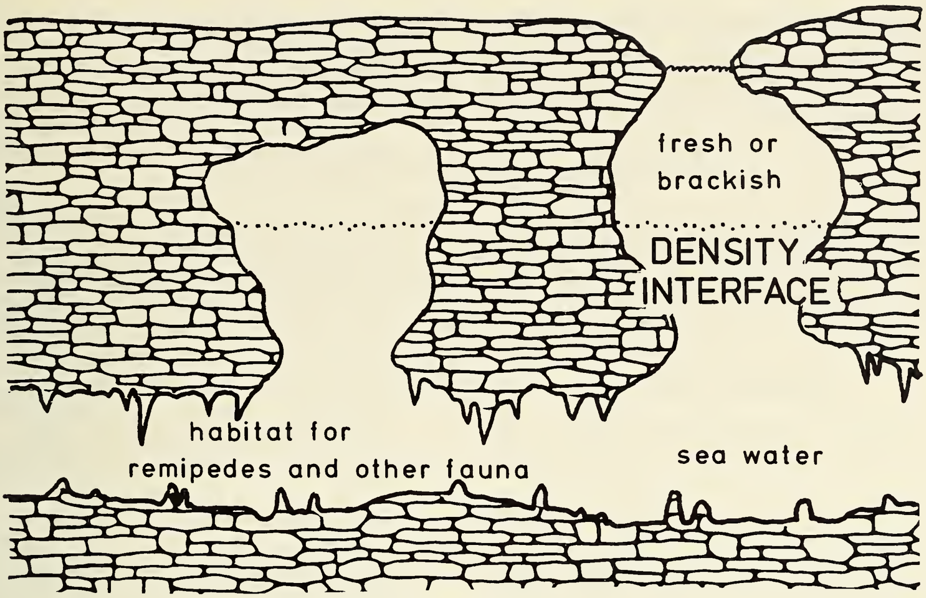

Fig. 12. Diagram of typical anchialine cave of the West Indies.

tain waters with dissolved oxygen values higher than 1 ppm (T. M. Iliffe, pers. comm.).

The low oxygen anchialine ecosystem can be considered a refugium because it represents a "stable" habitat. Although the caves accessible to divers today are geologically young, the Bahama Banks contain numerous caves at greater depths, providing a crevicular habitat that has been available for colonization throughout the 150 million year history of the Bahamas Platform. The low oxygen anchialine fauna may be descendants of taxa that have inhabited this environment for millions of years relatively unaffected by surface climatic changes, and the low oxygen ecosystem may have served as a refugium for species that were able to survive oceanic anoxic events (Degens and Stoffers 1976, Arthur and Schlanger 1979).

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Literature Cited

Arthur, Michael A., and Seymour O. Schlanger. 1979. Cretaceous "oceanic anoxic events" as causal factors in development of reef-reservoired giant oil fields.—American Association of Petroleum Geologists Bulletin 63(6):870–885.

Cunliffe, Sarah. 1985. The flora and fauna of Sagittarius, an anchialine cave and lake in Grand Bahama.—Cave Science 12(3):103–109.

Degens, Egon T., and Peter Stoffers. 1976. Stratified waters as a key to the past.—Nature 263:22–27.

Garcia-Valdecasas, Antonio. 1984. Morlockiidae new family of Remipedia (Crustacea) from Lanzarote (Canary Islands).—Eos 60:329–333.

Holsinger, John R., and Jill Yager. 1985. A new genus and two new species of subterranean amphipod crustaceans (Hadziidae) from the Bahamas and Turks and Caicos Islands.—Bijdragen tot de Dierkunde 55(2):283–294.

Iliffe, Thomas M., Horst Wilkens, Jakob Parzefall, and Dennis Williams. 1984. Marine lava cave fauna: composition, biogeography, and origins. Science 225:309–311.

Schlager, W., and R. N. Ginsburg. 1981. Bahama carbonate platforms: The deep and the past.—Marine Geology 44:1–24.

Schram, Frederick R., Jill Yager, and Michael J. Emerson. 1986. Remipedia. Part 1. Systematics.—San Diego Society of Natural History Memoir 15:1–60.

Sket, Boris, and Thomas M. Iliffe. 1980. Cave fauna of Bermuda.—International Revue der gesamten Hydrobiologie 85(6):871–882.

Yager, Jill. 1981. Remipedia, a new class of Crustacea from a marine cave in the Bahamas.—Journal of Crustacean Biology 1(3):328–333.

———, and Frederick R. Schram. 1986. *Lasionectes entrichoma,* new genus, new species, (Crustacea: Remipedia) from anchialine caves in the Turks and Caicos, British West Indies.—Proceedings of the Biological Society of Washington 99(1): 65–70.

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